

Original Research Article

Percutaneous nephrolithotomy for large renal stones in anomalous kidneys

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ABSTRACT

Background: Percutaneous nephrolithotomy (PCNL) is an important surgical method for managing renal stones of any size. Anomalous kidneys pose additional technical challenge to the operating surgeon to perform PCNL in these anatomically abnormal kidneys especially if the stone load is large. The aim of this study is to present the efficacy and limitations of PCNL in managing stones >2 cm in size in anomalous kidneys.

Methods: This was a retrospective single centre study of PCNL in anomalous kidneys with stones >2 cm in size.

Results: 30 patients of kidney stones >2 cm underwent PCNL. Our series of patients included 19 (63.32%) cases of horseshoe kidneys, 9 (30%) malrotated kidneys, 1 (3.34%) pelvic and 1 (3.34%) crossed fused ectopia. We achieved complete stone clearance in 26 (86.67%) patients. Presence of staghorn calculus was the most important statistically significant factor limiting complete clearance.

Conclusion: PCNL is an effective procedure for management of patients with large stones in anomalous kidneys. Appropriate preoperative evaluation especially imaging, appropriate selection of cases and most importantly excellent technical expertise is needed to achieve high stone clearance rates with minimal morbidity.

Keywords: Anomalous kidneys, Horseshoe kidney, PCNL

INTRODUCTION

Urolithiasis has affected the human race for centuries. It affects 4-15% of the world population and its incidence appears to be increasing.^{1,2} The problem of stone disease and its management becomes more complex in patients harboring anatomically abnormal kidneys which includes abnormalities of ascent, form, fusion, malrotation, pelvicalyceal and vascular abnormalities. In these kidneys not only the incidence of stone disease increases but also management options can be technically demanding. Horseshoe kidney is the most common congenital renal fusion anomaly, affecting 1 in 400 live births and ectopic kidneys occur in approximately 1 in 900 live births.³ The abnormal position of such kidneys

can be pelvic, iliac, abdominal, thoracic, or crossed, which may then become fused. Most ectopic kidneys are malrotated to some extent. These anomalous kidneys are more prone to calculus formation because of abnormally positioned ureteropelvic junction (UPJ), vascular compression from an accessory or main renal artery or high insertion or distortion of upper ureter or UPJ by dense amount of fibrous tissue, as well as concomitant infection and metabolic abnormalities.⁴

Calculi in kidneys with anomalous anatomy pose a particular challenge for the urologist. Because of aberrant anatomy these kidneys may not be amenable to the same approaches employed for stone disintegration or extraction as in normal renal units. The salient points to

be especially considered for performing PCNL in these patients are abnormal anatomy (calyceal and renal orientation), abnormal placement and relative immobility interfering with movement of equipment, abnormal relation to other visceral organs and abnormal vasculature.⁵

In this article we present our experience of performing PCNL for large stones (>2 cm) in anomalous kidneys.

METHODS

This study is a retrospective observational study and includes 30 patients which underwent PCNL for large renal calculi (>2 cm) in anomalous kidneys at our hospital from July 2017 to July 2020. These included 19 (63.32%) cases of horseshoe kidneys, 9 (30%) malrotated kidneys, 1 (3.34%) pelvic and 1 (3.34%) patient of crossed fused ectopia. All the patients were initially clinically worked up and then imaging was done in the form of ultrasound abdomen, X-ray KUB and CT-program. All relevant blood investigations were done including urine culture sensitivity. ⁹⁹Tc DTPA scan was done in patients in whom renal function was in question. CT-program was the main investigation which we used to determine the surgical approach of PCNL.

The procedure was done under general anaesthesia with endotracheal intubation. After induction patient was positioned in lithotomy position. Cystoscopy and ureteric catheterization (5Fr open ended) were done using the rigid cystoscope. The patient was carefully turned prone and draped using standard aseptic precautions. Stone is visualized using fluoroscopy (Figure 1). Percutaneous access into the desired calyx was guided by using contrast pyelogram (Figure 2). Fluoroscopic guided puncture was done in all patients which was followed by securing the tract with 0.035-inch hydrophilic guide wire (Figure 3). After initial dilatation with teflon dilators alkene telescopic metal facial dilators were used for further dilatation and this was followed by placing the desired sized Amplatz sheath. Small calculi if present were removed intact while the larger ones were first fragmented with pneumatic lithotripter (Swiss LithoClast master) and then retrieved. Complete stone clearance was confirmed on table using both fluoroscopy (Figure 4) and nephroscopy. DJ-stent 5Fr was placed in all cases. Nephrostomy catheter was placed if deemed necessary. On the first post-operative day X-ray KUB was done in the morning. In patients with complete clearance nephrostomy tube and foley catheter were removed on the same day. In patients who had residual fragments or in whom 2nd stage PCNL was planned tubes were not removed and patient was prepared for the 2nd sitting of PCNL next day. Intraoperative and postoperative parameters were studied in detail as per study proforma. In one case of pelvic kidney combined laparoscopic and fluoroscopic guidance was used to puncture the kidney and dilate the tract (Figure 5).

Date analysis was done using SPSS 22.0 software. Continuous values were presented as mean \pm standard deviation (SD), student t-test and Mann-Whitney U test were used for analysis. Non-continuous numeric values were expressed as median and range. Categorical variables were represented as percentage (%) and analysed using chi-square test or Fisher's exact test as appropriate. P value less than 0.05 was considered as statistically significant.

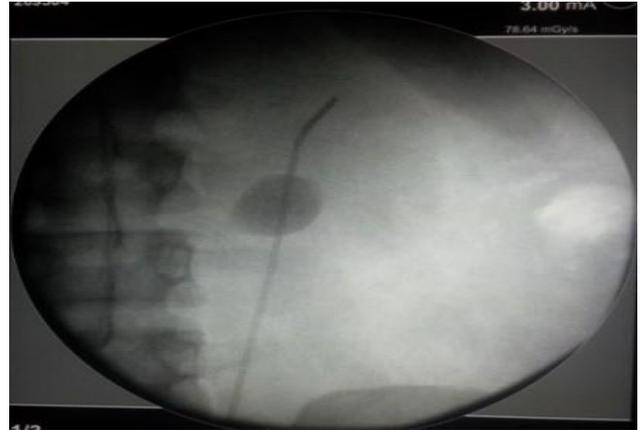


Figure 1: Calculus in horseshoe kidney seen under fluoroscopy.

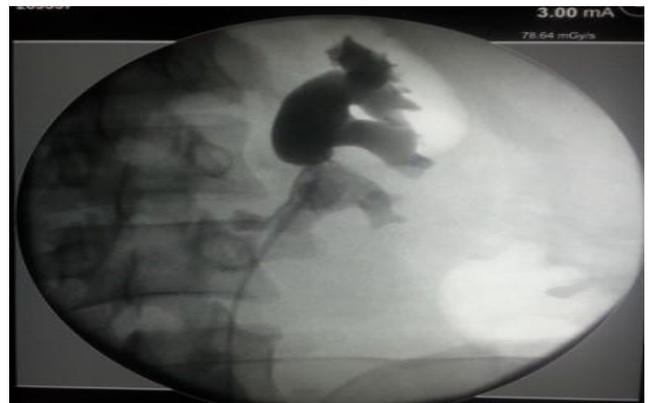


Figure 2: Contrast pyelogram of horseshoe kidney.

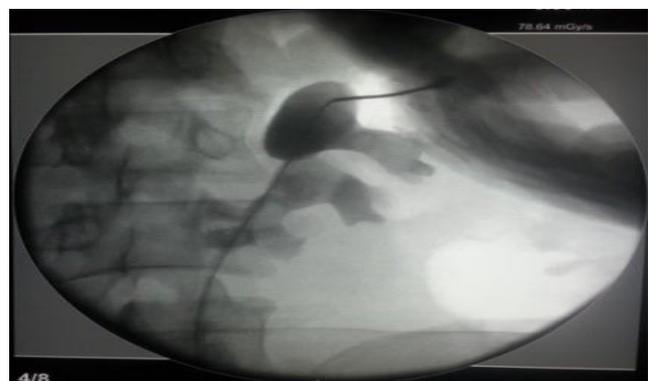


Figure 3: Superior calyceal puncture of horseshoe kidney.

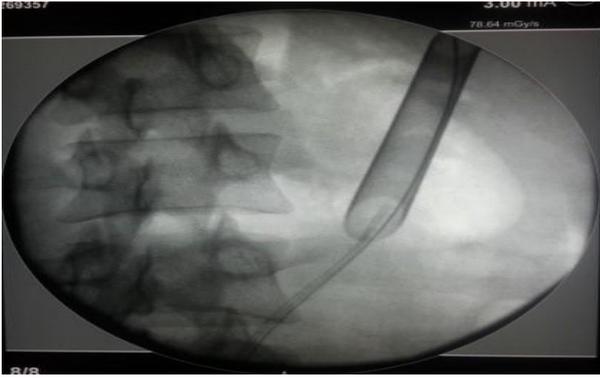


Figure 4: Complete stone clearance.



Figure 5: Combined laparoscopic and fluoroscopic puncture in pelvic kidney.

RESULTS

In our study 30 patients of renal calculi in anomalous kidneys were subjected to PCNL. The mean age of the patients was 39.5 years with the range of 13-65 years. The body mass index (BMI) was 29.87 ± 1.36 kg/m² (22.83 to 35.5 kg/m²). Flank pain was the presenting symptom in 65% of cases, hematuria in 15% and rest had nonspecific complaints. Urine culture positivity was in 5 (16.67%) cases. Out of 30 patients 19 (63.32%) had horseshoe kidneys, 9 (30%) had malrotated kidneys, 1 (3.34%) had pelvic and 1 (3.34%) crossed fused ectopia. There were 14 (46.67%) cases with solitary calculi and 16 (53.33%) patients with multiple calculi. In 23 (76.67%) patients stone size varied between 20-29 mm and between 30-39 mm in 2 (6.66%) cases while 5 (16.67%) cases had stone size above 50 mm. Mean stone size was 702.56 ± 410.22 mm² with the range of 304-1750 mm².

In our series 12 (40%) patients had calculi in right kidney and in 18 (60%) in left kidney. Patient with crossed fused ectopia (right to left) had calculus on left side, superior calyx of crossed right kidney. In 29 (96.67%) patients PCNL procedure was done in prone position while in 1 (3.33%) case of pelvic kidney PCNL was done in supine position.

In 29 (96.67%) patients' fluoroscopies was used as guide to puncture the pelvicalyceal system. While in 1 (3.34%)

patient with pelvic kidney combined fluoroscopy and laparoscopic assistance were needed to gain access into pelvicalyceal system. Supracostal (supra 12th rib) puncture was used in 2 (6.67%) patients, one each of malrotated kidney and crossed fused ectopia, none of them developed any thoracic complication. Infra costal (infra 12th rib) approach was used in 27 (90.00%) cases. In patient with pelvic kidney access was made by piercing the lower left quadrant of anterior abdominal wall.

Post-operative drainage was primarily provided by DJ-stents in all patients. In 5 (16.67%) patients nephrostomy tube was additionally used for pelvicalyceal decompression after the completion of the procedure.

The intraoperative complications which we faced were, in 2 (6.67%) patients bleeding and in another 2 (6.67%) patients calyceal tears. In all 4 cases procedures were completed uneventfully without any blood transfusion.

Postoperatively 3 (10%) patients developed fever, which was managed by antibiotics only. None of them required ICU admission. In our 30 cases of PCNL, 26 (86.67%) patients had complete stone clearance, 22 (73.34%) patients in one stage and in 4 (13.34%) cases two stages. 100% stone free rate was achieved in cases having malrotated, crossed fused and pelvic kidneys while in 4 (21.05%) patients of horseshoe kidneys PCNL failed to completely clear the stone burden. The overall success rate achieved in our series of PCNL patients was 86.67%. PCNL failure cases were rendered stone free by flexible ureteroscopy. The factors which has strong statistical correlation ($p < 0.05$) with stone free rate after PCNL therapy were PCS morphology (absence of hydronephrosis decreases stone clearance) of anomalous kidneys ($p = 0.036$), multicalyceal location of calculi ($p = 0.048$) and presence of staghorn calculi ($p = 0.0002$). Out of these factors presence of staghorn calculi has the strongest statistical correlation with decreased stone clearance ($p = 0.0002$).

DISCUSSION

In urological practice fusion and malrotation anomalies are the most common types of renal abnormalities presenting with stones. The most commonly preferred modalities of treatment for management of stones in anomalous kidneys are SWL and flexible ureteroscopy for stones less than 2 cm in size and PCNL for stones more than 2 cm in size. The stone free rates have varied from 72-92% in different reported series. The PCNL remains the reference standard for larger stone burdens and shock wave lithotripsy (SWL) resistant or failure cases.

The incidence of ectopic kidneys at autopsy is approximately 1:900 with no predilection for gender. Fusion and abnormal placement leads to relative anterior position of renal pelvis, calyces more posterior than

usual, combination of aberrant vasculature which are at times extremely variable. The most common renal fusion anomaly is the horseshoe kidney (1:400 in live births) having anterior pelvis, fused lower pole, low lying position in abdomen and aberrant vessels or vascular anomalies. These kidneys usually have high insertion of ureter leading to impaired urinary drainage and increased incidence of stone formation. There is approximately 14% incidence of stones in horseshoe cases. In anomalous kidneys the abnormal relationship of the kidney to surrounding viscera is of deep concern to a surgeon as the risk of visceral injuries is a real possibility.

The various factors responsible for higher incidence of urolithiasis in anomalous kidneys includes the abnormal renal and pelvicalyceal position, UPJ distortion/obstruction, aberrant renal vessels or vascular anomalies, fibrous bands, and adhesions, isthmus compression in some of the cases leading to impedence of urinary drainage more urinary stasis, concomitant infection and metabolic abnormalities causing increasing stone burden and complex calculi. In many patients of anomalous kidneys visceral organs abnormalities and skeletal difficulties are other associated factors complicating management. Although SWL and flexible ureteroscopy is a reasonable choice for anomalous kidneys with small stone burden below 2 cm in size however PCNL is an effective procedure for the management of patients with large complex stones. PCNL is challenging in these cases. Positioning, puncture guidance, number of punctures and calyceal access and tract dilatation and mobility of nephroscope are difficult during PCNL in these cases. There are limited published reports on PCNL for anomalous kidneys where stone burden was large.

A good number of studies in the literature are available about management of stone disease in horseshoe kidneys. However, there are limited published data available on PCNL studies which have included all types of anomalous kidneys. Mosavi-Bahar et al demonstrated a series of 16 patients of complex calculi in anomalous kidneys and reported 81% stone clearance by PCNL.⁶ However, a greater number of published series of managing calculi in horseshoe kidneys only are demonstrated in the literature.

On reviewing the CROES PCNL global study database in 2011 meta-analysis suggests total number of 202 renal malformation cases with male predominance, mean age was 47.5 years, BMI 26.5 (22.9-29.3) kg/m² and renal stone burden varied from 235.5-572.6 (mean 392.5) mm³. Stone free rate achieved was 76.6%.⁷

In our series of patients as regards the level of access into the pelvicalyceal system majority of patients were given prone position, infracostal (12th rib) approach was chosen in 27 (90%) cases while supracostal (12th rib) in 2 (6.66%) cases and 1 (3.33%) case required anterior abdominal approach in supine position. In 19 cases of

horseshoe kidney superior calyceal puncture was made in 12 cases, middle calyceal puncture in 1 and 6 cases required superior and middle calyceal puncture. In 9 cases of malrotated kidneys infracostal approach was used in 8 while supracostal in 1 case. Inferior calyceal puncture in 7 cases while in 2 cases combined superior and middle calyceal and superior and inferior calyceal punctures were needed respectively.

Mosavi-Bahar et al in 2007 reported PCNL in 16 cases of anomalous kidneys in which superior calyceal puncture in 8, central in 4 and lower polar in 4 cases. 14 required one tract and 2 required 2 tracts.⁶ Osther et al reported puncture site in 202 cases of renal malformation as upper polar 65, middle 45, lower 82 and multiple in 10 cases.⁷ Above 12th rib access 40 cases while below 12th rib 160 and above 11th rib 2 cases.

Our preference was for prone position, infra-costal approach and superior calyceal puncture was done in majority of cases with no regrets. The tract dilatation and Amplatz sheath size varies according to age, degree of pelvicalyceal dilatation and stone burden of the patient.

Gupta et al demonstrated operative time parameters in total of 46 patients of PCNL in anomalous kidneys.⁴ Mean operative time of 70 (30-100) minutes in 31 cases of horseshoe kidney, 85 (70-100) minutes in 4 cases of crossed fused ectopia, 75 (50-150) minutes in 7 malrotated kidneys and 100 (80-140) minutes in 4 cases of pelvic kidneys.

In current study in 19 cases of horseshoe kidney the mean operative (nephroscopy) time was 74.3 (45-110) min, in 9 malrotated cases operative time was 67.27 (45-98) min, and in 1 case of crossed fused ectopia 75 min while in 1 case of pelvic kidney 105 minutes. The Osther et al in 2011 noted median operative time (IQR-interquartile range) for 202 renal malformation cases of PCNL as 87.0 (55-120) min.⁷

The operative time (PCNL) in renal anomalies calculous disease cases is always more in comparison to normal anatomical situation. The operative time varies according to the position of kidney, type of anomaly, associated pelvicalyceal configuration, UPJ/vascular pathology and visceral organ anatomy. It is equally important that more operative time will be taken in cases with over whelming stone burden and multicalyceal stone location.

Overall success rate of PCNL amongst our cases was 26 (86.67%). In 9 cases of malrotated and 1 case each of cross fused and pelvic ectopic kidneys the stone clearance and overall success was 100%. The overall success in horseshoe kidney cases it was only 78.95% (15/19 cases of HSK).

Overall failure was noted in 4 (13.33%) cases which all were of horseshoe kidneys. In all these cases calculi in medially directed calyces in the isthmus could not be

cleared by PCNL. These were later managed successfully by flexible ureteroscopy.

The published reports of stone free rates of PCNL in anomalous horseshoe kidneys reported by various authors varies from 73.5 to 88% as demonstrated by Ganpule et al in 2011.⁵ Recently some publications have achieved 100% clearance by laparoscopic assisted PCNL in pelvic kidneys. The Mosavi-Bahar et al in 2007 experienced 81% success of complete stone clearance on single stage PCNL.⁶ They confirmed complete stone clearance by 2nd look PCNL procedure alone or SWL in 1 case of malrotated and 2 cases of horseshoe kidneys with staghorn calculi.

In our series of patients age, sex, BMI, type of renal anomaly, size and number of calculi did not have any statistically significant impact on stone free rates.

The factors which are of strong statistical significance ($p < 0.05$) to stone free rates after PCNL therapy were pelvicalyceal system morphology of anomalous kidney ($p = 0.036$) multicalyceal location of stone ($p = 0.048$) and presence of large stone burden in the form of staghorn calculi ($p = 0.0002$). Out of these factors larger stone burden (staghorn) was the strongest statistically significant.

In our opinion PCNL in the management of urolithiasis in anomalous kidneys having stone size of 2 cm and above is very safe, effective and highly successful with minimal morbidity. Though, it is challenging because of abnormal anatomy and associated vascular anomalies, abnormal visceral organ relationship and relatively restricted mobility interfering with the movements of nephroscope. However, proper evaluation, appropriate selection of cases, and good training in percutaneous renal stone surgery one can manage such cases as parallel to PCNL in anatomically normal kidneys.

The limitations of our study were the relatively small series of patients and the unavailability of flexible nephroscope which could have further improved our success rate by accessing medially directed calyces in horseshoe kidneys.

CONCLUSION

PCNL is an effective procedure for management of patients with large renal calculi in anomalous kidneys.

However, PCNL is challenging in these cases. Appropriate preoperative evaluation especially understanding imaging is critical and the presence of excellent technical expertise is needed to achieve high stone clearance rates with minimal morbidity.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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